

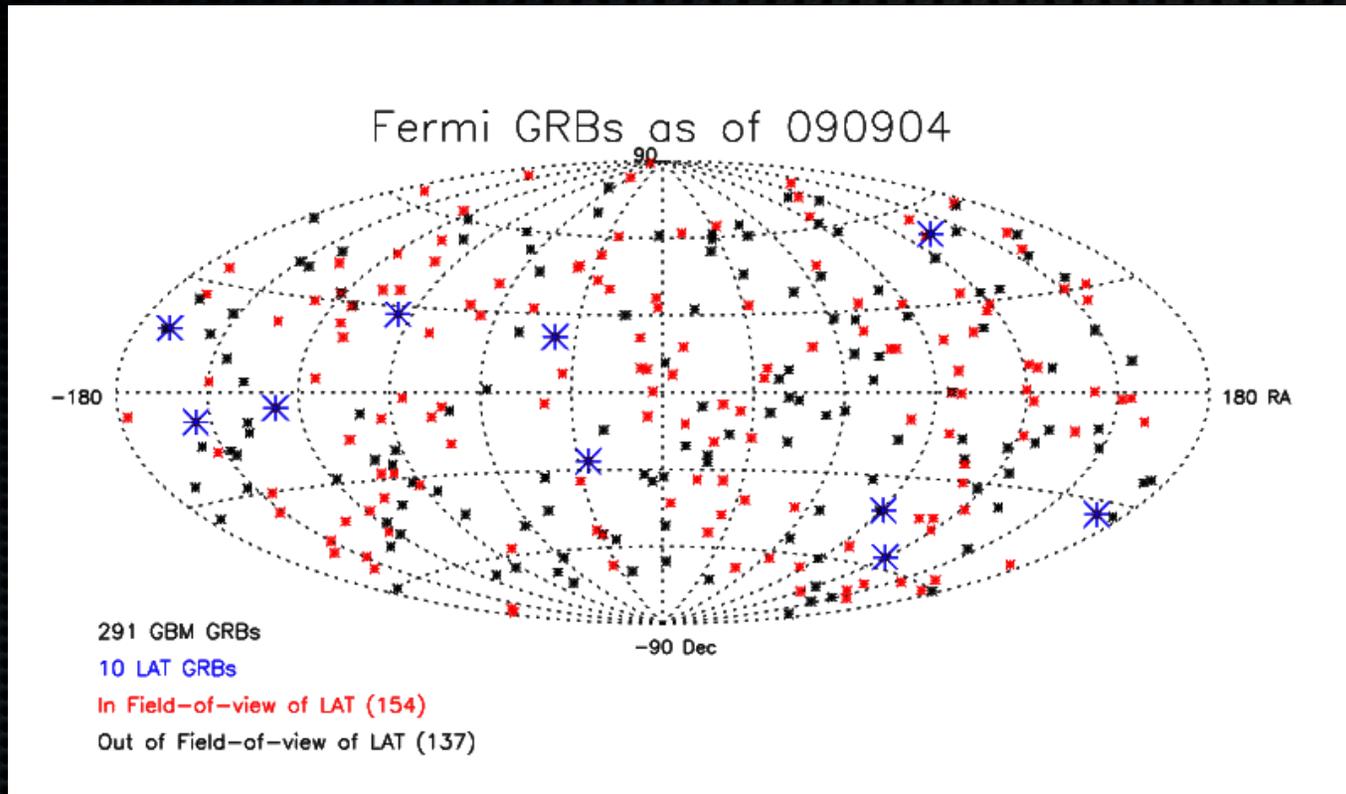
Fermi-LAT Upper Limits on Gamma-ray Bursts

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On behalf of the Fermi collaboration

Fermi GRB Detections



- 291 GBM detections

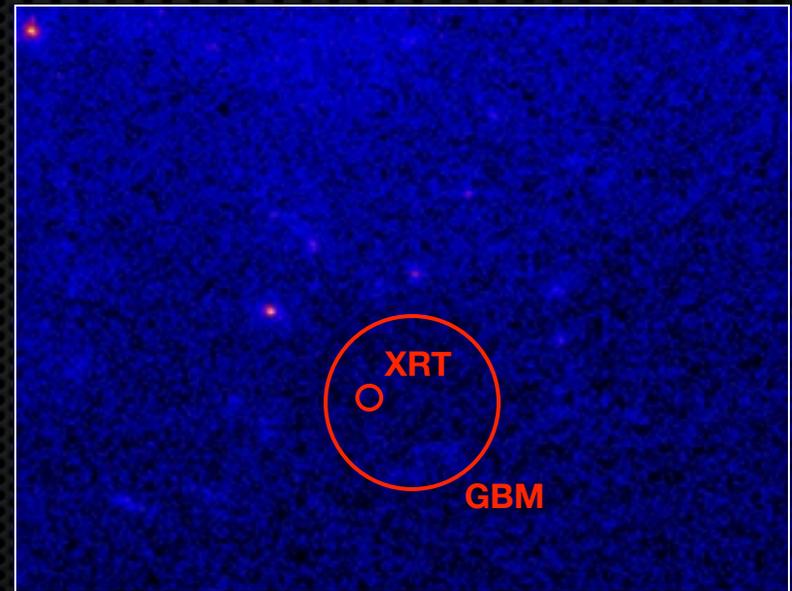
- Rate ~ 0.7 events/day

- 10 LAT detections

- LAT is detecting roughly 3%

LAT Upper Limits on GRBs

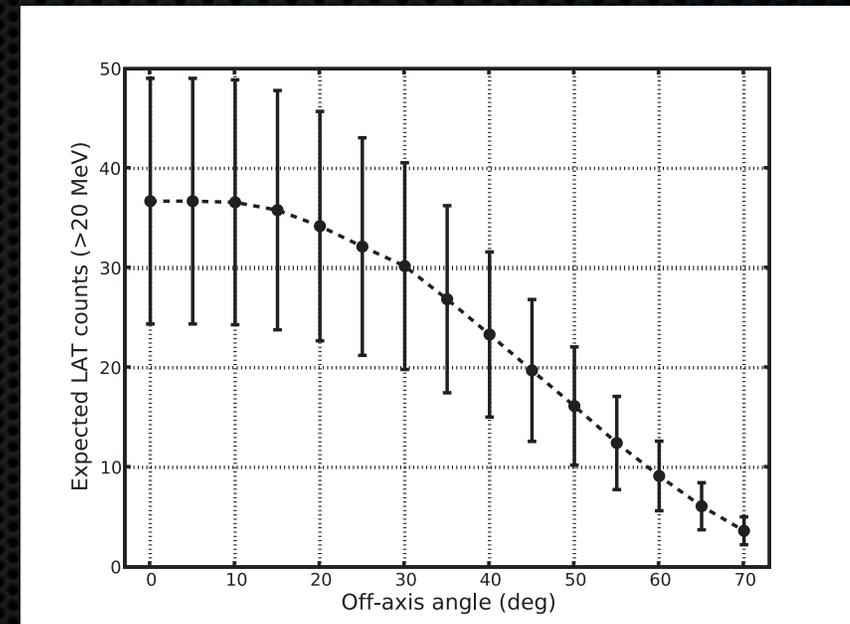
- What are the upper limits to the 0.1-300 GeV flux for GBM only bursts?
- Can we rule out high energy emission for these events?
- How do these upper limits compare to the expected flux?
- Could point to interesting physics
 - Intrinsic spectral breaks?
 - EBL or $\gamma - \gamma$ absorption?



LAT Count Map of hypothetical GRB Position

LAT Field of View (FOV)

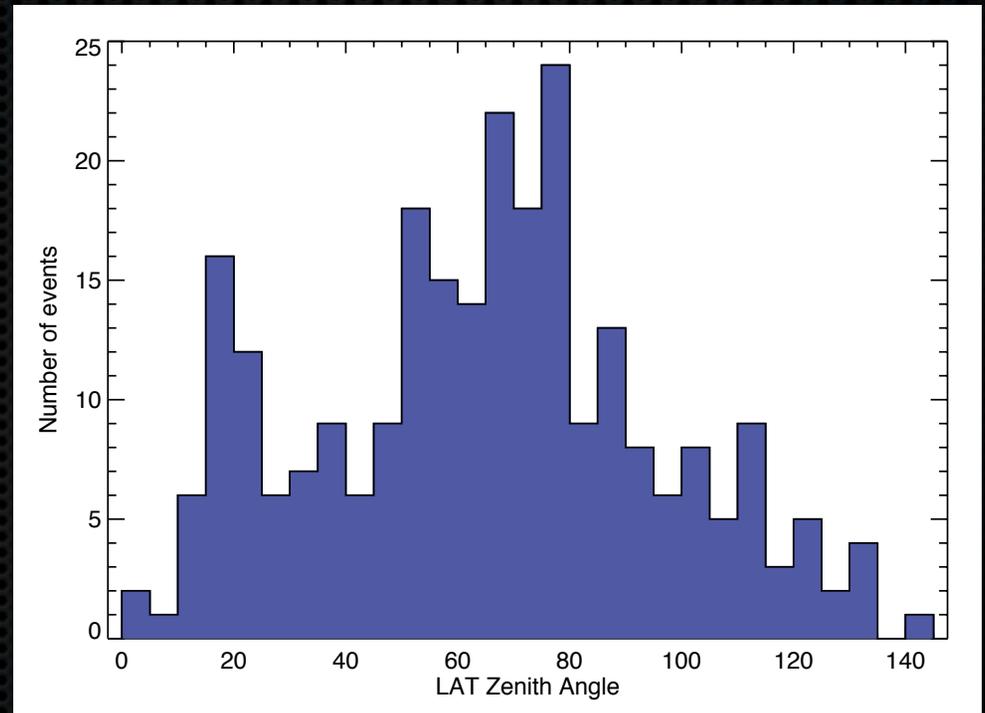
- ✦ Detector Fields of View
 - ✦ GBM: Full unocculted sky
 - ✦ LAT: ~ 2.4 Sr
 - ✦ LAT does not see all events
- ✦ Bursts in the LAT FOV
 - ✦ For this analysis:
 - ✦ $< 65^\circ$ from the LAT Boresight
 - ✦ Sensitivity decreased rapidly



Expected counts vs. boresight angle

Burst Demographics

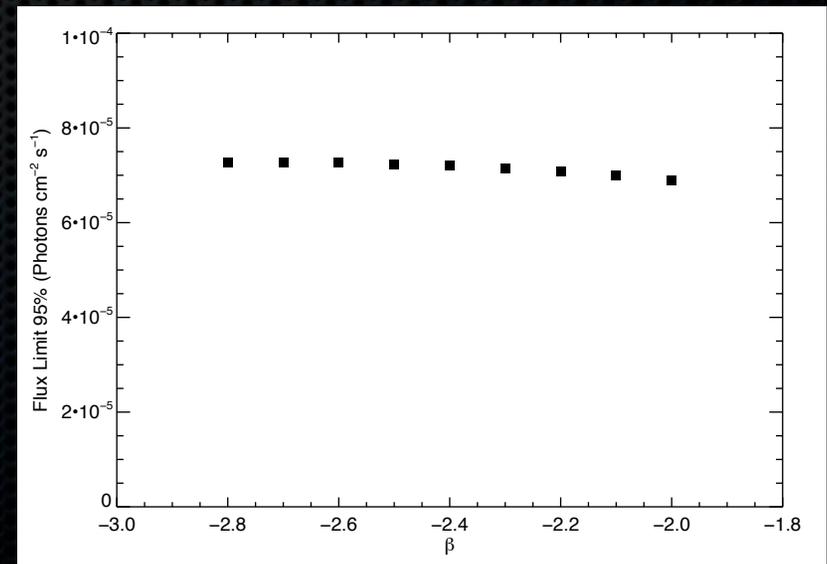
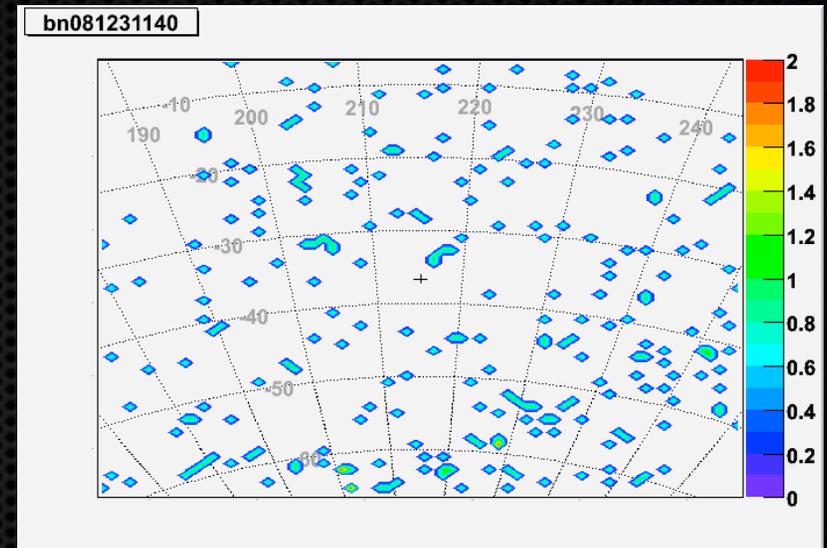
- ✦ GBM Detections
 - ✦ 291 events
- ✦ GBM Events in LAT FOV:
 - ✦ 154 events (52%)
- ✦ LAT Detections
 - ✦ 10 events was $\sim 3.4\%$
 - ✦ 10 events now $\sim 6.4\%$
- ✦ What can we say about remaining 52%?



Angle of GRB to the LAT boresight at GBM trigger

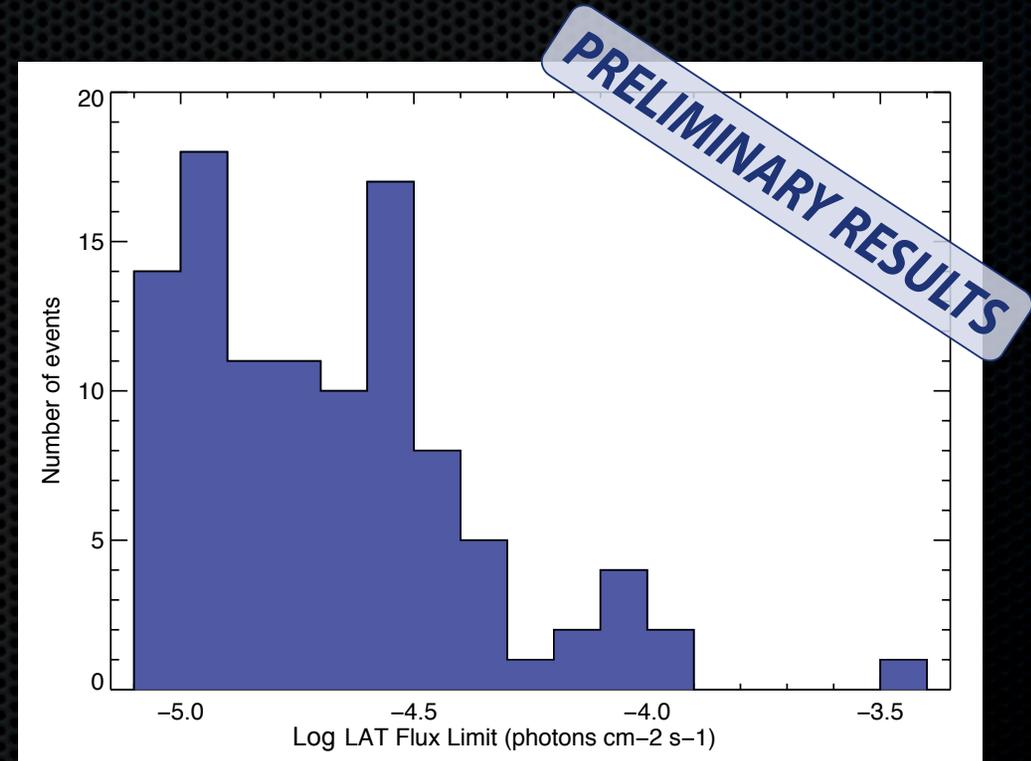
Flux Upper Limits Method

- Flux Upper Limit Calculations
 - Method based on Helene 1983
 - Spatially: 10 degree ROI
 - Temporally: T90
 - Also searched -200 to 200 s
- Spectral Slope
 - Assumed $\beta = -2.2$ for all events
 - Flux limit weakly depends on β
- Obtain 95% CL flux (or flux limit) and the significance of detection (TS value)



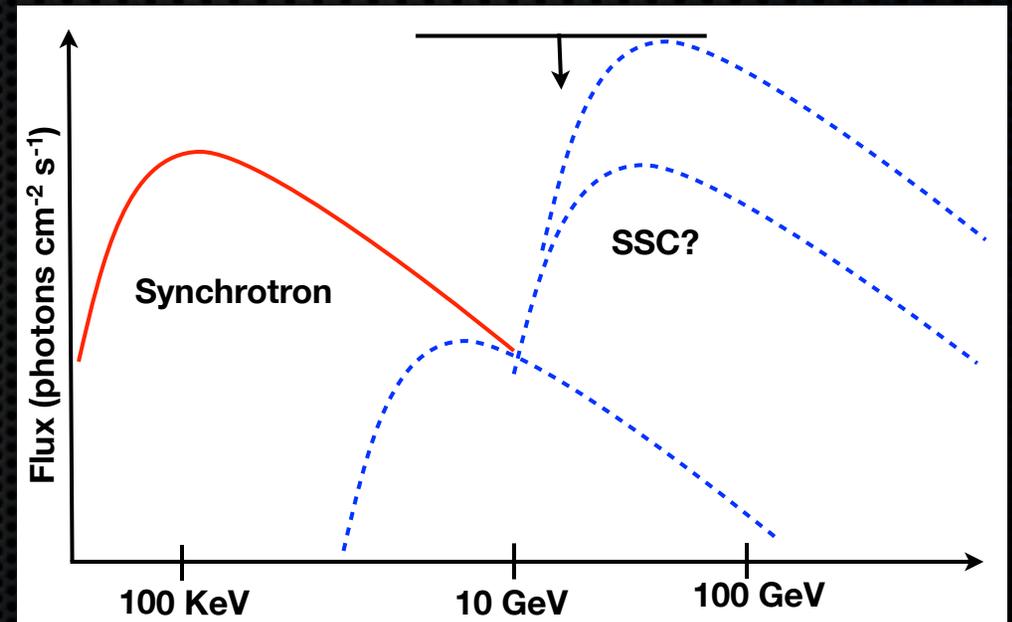
LAT Flux Upper Limits

- GBM events in LAT FOV:
 - 152 events (52%)
- Events with flux upper limits
 - 117 events (45%)
 - Assume beta = -2.2
- Median flux limit (0.1 to 300 GeV)
 - $\sim 2.6 \times 10^{-5}$ photons $\text{cm}^{-2} \text{s}^{-1}$
 - Over T90 duration
- Implications for extra components?



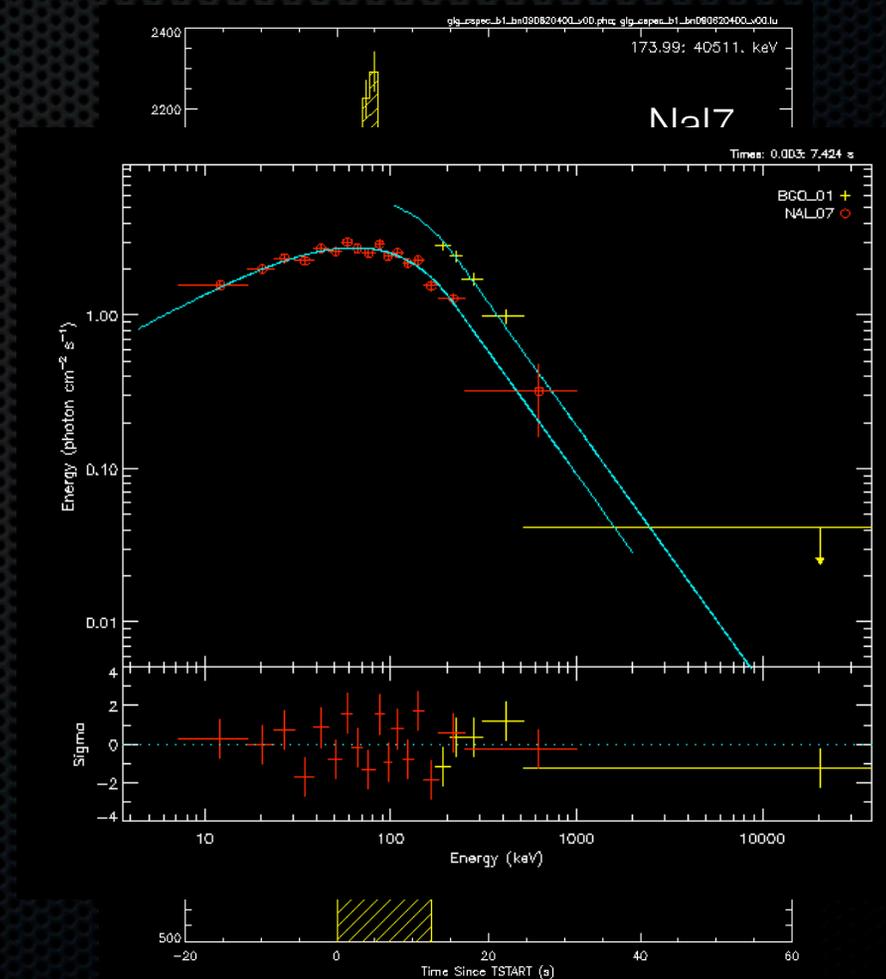
Extra Components

- SSC & pion decay components
 - No obvious evidence
 - Unless significantly delayed
- Implications of flux limits
 - $\Upsilon < 1$, $\epsilon_B > \epsilon_e$
 - $\gamma \gg 100$, $E_{pk,SSC} \gg 10$ GeV
 - EBL attenuation?
- No evidence for EBL in any LAT event



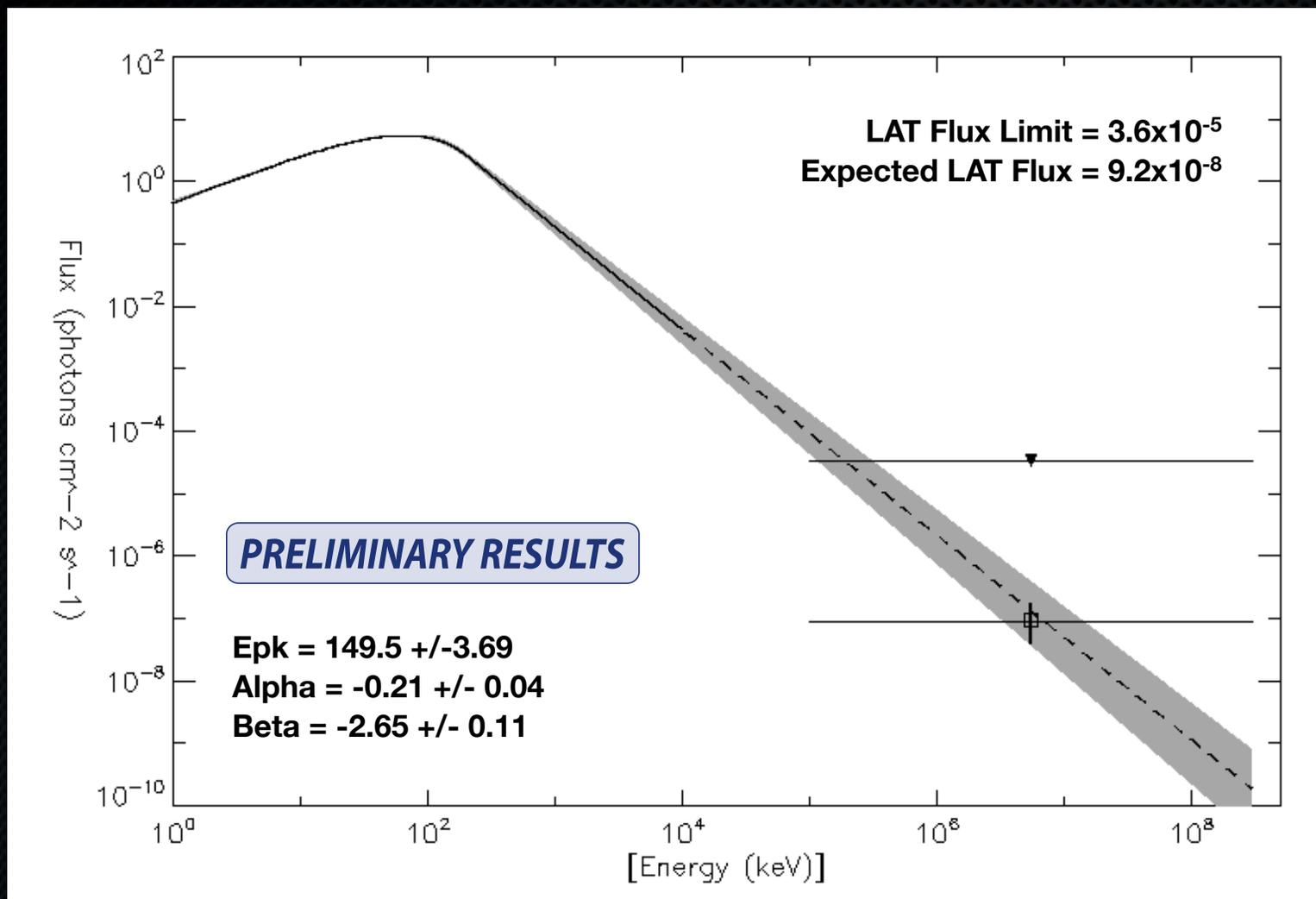
GBM Extrapolation

- Bright BGO Sample
 - GBM events with > 70 BGO cts
 - But no LAT detections
- 79 events
 - 33 in LAT FOV
- Performed spec fits with rffit
 - 15 events in “Gold” sample
 - Median beta ~ -2.3

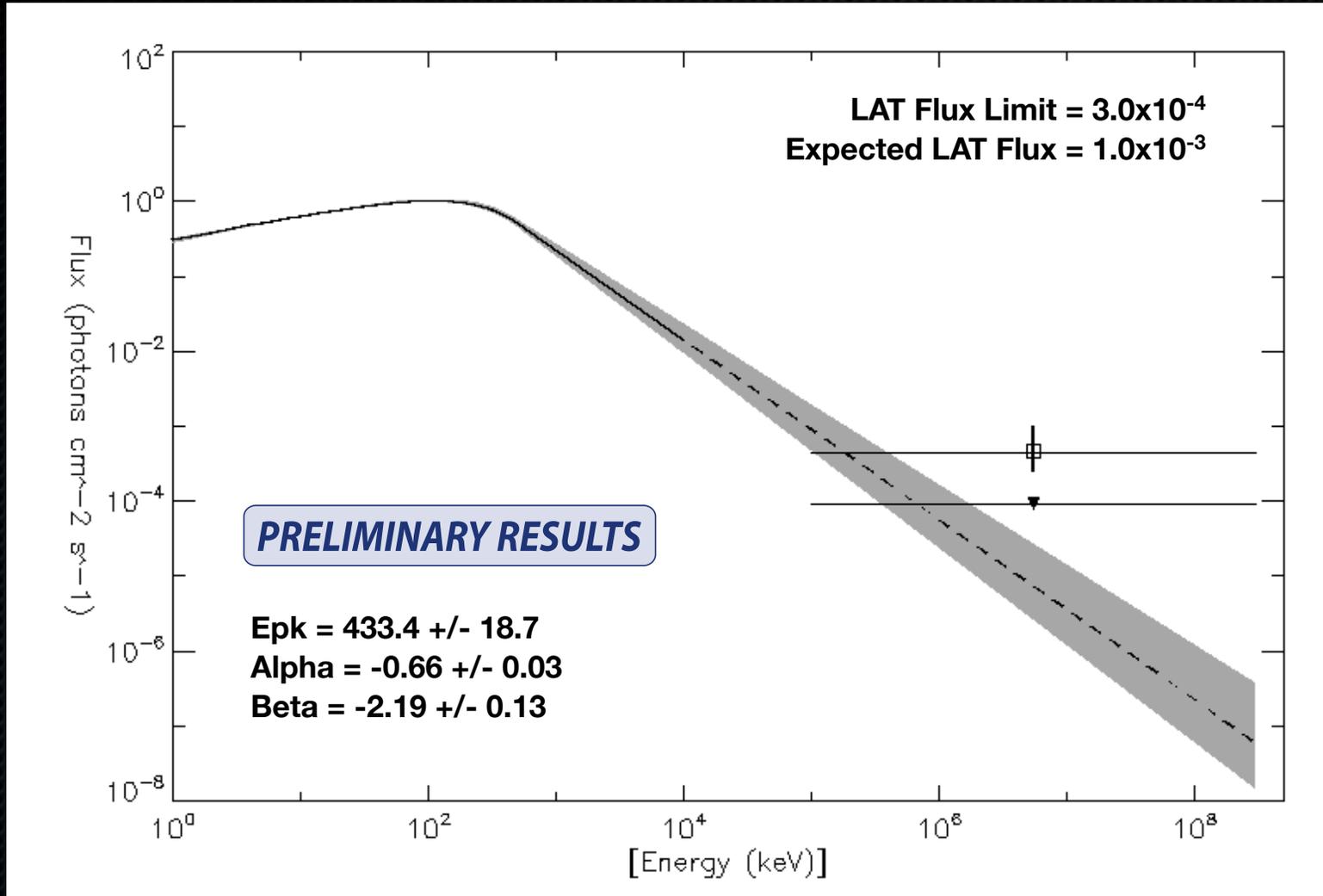


GRB 090620.400

GRB 090620.400

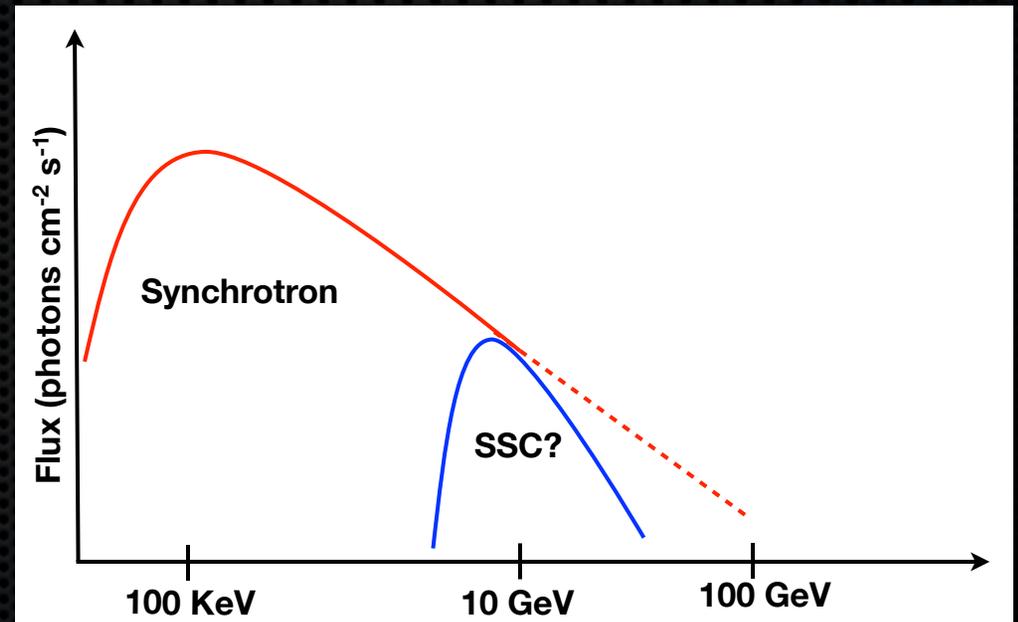


GRB 081207.680



Possible Explanations

- ✦ EBL attenuation
 - ✦ Test: Should vary with redshift
- ✦ γ - γ abortion due to compactness
 - ✦ Lower end of the Γ distribution?
 - ✦ Test: Correlate with E_{pk} , E_{iso} ?
- ✦ Finely tuned SSC peak
 - ✦ Mimic a spectral cutoff
 - ✦ Test: Detailed spectral fits



Conclusions

- ✦ Only ~52% of Fermi GRBs are in LAT field of view
 - ✦ Flux limit ~ few x 10^{-5} photons $\text{cm}^{-2} \text{s}^{-1}$
- ✦ Bright BGO Sample
 - ✦ ~80% of “Gold” sample do not predict LAT counts
 - ✦ ~20% do show discrepancies that hint at spectral curvature
- ✦ Explanations?
 - ✦ Extra-galactic background light attenuation
 - ✦ gamma-gamma absorption due to compactness at the source
 - ✦ Finely tuned SSC peak located near the break
- ✦ Look for a paper on this topic soon!